Laparoscopic Incisional and Ventral Hernia Repair

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Karl A. LeBlanc

Introduction

Approximately 350,000–500,000 ventral hernias are repaired in the USA yearly.[1] This common problem has been approached in a myriad of ways, each with various technical aspects that contribute to the long-term success or failure of the repair. Laparoscopic incisional-ventral hernia (LIVH) repair, as first described by LeBlanc in 1993 [1], builds upon the strengths of various techniques that improve overall outcome. The significant mesh overlap in the rectro-rectus repair with transfascial fixation first described by Rives and Stoppa [2, 3] is technically similar to what is achieved in LIVH repair.

Though some still commonly perform primary suture repair of ventral hernias, it has been shown to have a recurrence rate of 54–63% [4, 5]. When primary suture repair was compared to open mesh repair, open mesh repair was found to have a recurrence rate of 32% [5]. Though some advocate the recurrence rate to be equivalent between open mesh repair and LIVH [4, 6], multiple other studies show LIVH to be superior in the rate of hernia relapse [7, 8]. Three prospective trials comparing laparoscopic ventral hernia repair to open mesh repair show the recurrence rate for LIVH to be 2–3.3% in comparison to open mesh repair which is reported to be 1.1–10% in these studies [6, 8, 9]. LIVH has been generally shown to be superior to open mesh repair in postoperative wound complications, hospital length of stay, and identification of multiple defects [6–11]. Recent evidence appears to favor the laparoscopic repair for recurrent hernias [12].

The repair of incisional and ventral hernias by the laparoscopic approach should be performed by high-volume laparoscopic surgeons. The surgeon should be adept at performing the more common laparoscopic operations and also be comfortable to perform the more complex laparoscopic procedures. The assistance of another surgeon during this operation is felt to be of great benefit in most occasions. This chapter will present the concepts, technical aspects, and results of the LIVH as it is currently performed. There are variations of the technique that are presented within this chapter, as is common to every surgical procedure. This methodology is continuing to evolve and undoubtedly will be modified as newer prosthetic biomaterials and instrumentation are developed in the future. One such advancement is the laparoscopic approach to component separation. Multiple studies have shown that myofascial advancement can be achieved with minimal flap dissection and improved wound outcome [13–15].

Preoperative Evaluation

In general, if a patient is a medically appropriate candidate for open hernioplasty, then he or she could be considered a candidate for the laparoscopic approach. Patients that have significant cardiac decompensation may experience physiological abnormalities during the procedure because of the insufflation and resulting decrease in the venous return. Lower insufflation pressures may decrease the hemodynamic fluctuations [16]. Preoperative preparation of the patient is important because postoperative complications are a predictor of recurrence [17].

Generally almost all hernias are candidates for the LIVH. Even the smaller hernias in obese individuals could be repaired with this technique. Recurrence rates have been shown to be higher in obese patients [18–20]. Yet the benefits of less wound complications and the ability to identify the occult defects that are missed during an open approach make LIVH a viable option for obese patients. One may opt to use the open approach in a thin patient if it is apparent that

[1]Society of American Endoscopic and Gastrointestinal Surgeons (SAGES) website (www.sages.org).

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the defect is 3 cm or less [18]. Some even recommend the avoidance of hernia surgery at all if the body mass index is greater than 50 [21]. The laparoscopic method, however, is preferred in this group of patients [22].

A very large fascial defect that nearly encompasses the entire anterior abdominal wall may pose a difficult problem. A laparoscopic approach, however, may be feasible. The decision to attempt the laparoscopic method should be based upon the experience of the surgeon, the number of prior operative procedures, mesh repairs, the type of prosthetic utilized in any previous repair(s), and the location of the potential hernia sites. However, there are currently no "hard and fast" rules about this issue. In those patients with very large defects, a reasonable option would be to commence the operation laparoscopically and convert to an open repair if that appears to be the best alternative. More often than not, this proves to be unnecessary. A probable exception to this sequence is those individuals that exhibit a "loss of domain" of the abdominal contents. In these patients, it is usually impossible to actually enter the abdomen behind the abdominal wall musculature because this musculature has been displaced so far laterally. In these cases, conversion to the open method would occur earlier rather than later. More commonly, however, prudence dictates that the entire procedure should be of the open type rather than even attempting the laparoscopic approach.

Absolute contraindications to the use of the laparoscopic method would be the presence of an acute surgical abdomen. A relative contraindication is intra-abdominal infection from any source. The use of a prosthetic biomaterial in the site of an overt infection may preclude the use of such a product. However, primary closure of the hernia defect with the assistance of a laparoscopic suture passer and biologic mesh [23] may have a role in such instances though an open repair may be indicated for gross contamination. There is data to support the use of mesh in contaminated fields, however [24]. Similarly, while the presence of incarcerated bowel does not prevent the performance of the procedure, strangulation of the bowel necessitates an open hernioplasty.

Because the most common incision of the abdomen is placed in the midline, most incisional hernias (approximately 90%) occur in the midline. When a surgeon begins to perform laparoscopic incisional hernioplasty, it is recommended that he or she should repair midline defects initially to gain confidence in use of the laparoscopic technique. Once this is accomplished, the presence of a non-midline defect or multiple defects that are not adjacent to each other should not preclude the use of laparoscopy. Appropriate positioning of the patient and accurate placement of the trocars will permit an approach to the entire abdominal cavity in most cases.

Previous intra-abdominal surgery is a major consideration in the evaluation of a patient for the laparoscopic procedure. The number and type of earlier operations will influence the choice of patient position, the method of abdominal entry, trocar placement, and the position of the monitors. This preoperative assessment will allow the surgeon to plan the operative procedure and the operative suite based upon these findings. Any previous open laparotomies will, of course, be associated with more potential for adhesion formation than procedures that were performed laparoscopically. Additionally, those patients in whom a previous incisional hernia repair included the implantation of any "unprotected" prosthesis can be expected to have dense scarring in all areas in which the material was exposed to the intra-abdominal contents. This is very uncommon today. This should not deter experienced surgeons from attempting a laparoscopic approach because as many as one-third of these patients will not have any adhesions at all. It is important to note, however, that the difficulty of the procedure can be greatly magnified because of the dissection of the tenacious scarring that is encountered involving the prosthesis and the bowel and/or omentum. The risk of enterotomy is significantly increased in such instances.

Patients in whom there is an additional need for a surgical procedure such as a cholecystectomy, fundoplication of the stomach, inguinal herniorrhaphy, or biopsy of an intra-abdominal or retroperitoneal structure are special subsets that deserve careful consideration. Hernia repairs in such cases are discussed later in this chapter.

Laparoscopic incisional hernioplasty should be individualized in patients with known ascites because it may be challenging to maintain a watertight closure that averts ascitic fluid leakage postoperatively. Moreover, these patients usually have a metabolic problem (e.g., chronic renal failure or hepatic disease) that can cause poor healing and predispose them to development of a hernia at the trocar sites. The use of the 5 mm trocars, however, has made this less problematic, and these patients may also be considered on occasion. Special trocars that do not cut into the abdominal muscle but dilate the tissues to enter through the wall of the abdomen should be used in these patients. The site of entry will be smaller than the actual trocar itself after it is removed thereby further minimizing the risk of leakage of ascitic fluid or subsequent herniation. Though the use of a prosthesis in patients with overt ascites is scarcely reported, some have achieved success with the LIVH in these patients with maximal optimization of ascites [25–27].

LIVH patients are admitted to the day surgery unit of the hospital because they can usually be considered for discharge on the day of surgery. The number and type of comorbid conditions of the patient, the type and location of the hernia(s), the presence of incarceration, and the amount of adhesiolysis required will influence the decision of timing of discharge from the hospital. Many patients now undergo laparoscopic incisional hernia repair in an ambulatory surgery center. Appropriate laboratory testing should be obtained prior to entry on the day of surgery. Patients are routinely given a preoperative dose of either a first-genera-

tion cephalosporin or a fluoroquinolone. If a patient has a history of methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin is used for preoperative prophylaxis. If there has been a prior mesh infection, it is preferable to delay surgery for 6 months, if possible, and give the antibiotic used to treat the prior mesh infection preoperatively.

Intraoperative Considerations

Patient Preparation and Positioning

LIVH repair requires the use of general anesthesia to achieve the necessary degree of relaxation and sedation. In most cases, it is not necessary to use an orogastric or nasogastric tube unless the site of initial entry is in the vicinity of the stomach. A urinary drainage catheter is not used if the procedure is felt to be short in length. If the operative site is close to the bladder (e.g., very low midline hernias or concomitant inguinal hernia repairs) or if the procedure will be prolonged, it is then advisable to insert a urinary drainage catheter; preferably a three-way catheter is used if it becomes necessary to fill the bladder for identification. Insertion of a nasogastric tube for procedures in which extensive dissection of the bowel is necessary may help to reduce the postoperative ileus that is likely to develop. It is seldom necessary to leave this tube beyond the intraoperative phase of the procedure, however.

Most patients will be placed in the supine position. Operations upon lateral defects of the abdominal wall, such as those in a subcostal or flank incision, will be facilitated by use of a semidecubitus or full decubitus position. The use of a "beanbag" or "jelly roll" in these instances will greatly aid in the positioning of the patient. The additional use of the tilt capabilities of the operating table will assist in the manipulation of the bowel during dissection. Steep Trendelenburg or reverse Trendelenburg positions will cause the abdominal contents to move into positions that will make visualization of the contents of both the hernia and the abdomen easier. The patient's arms should be tucked in close to the body to allow sufficient room to move around the patient; this is especially important if the defect is in the lower abdomen. Occasionally this may not be feasible due to the size of the individual, but, in general, it is preferred when possible. Use of a protective transparent adhesive drape to cover the skin is recommended.

Abdominal Entry

It is understood that the method of access into the abdomen should always be the safest approach possible. Many surgeons use the open type of Hassan entry because it is familiar to them. An open entry such as this could result in a poor seal around the trocar, which makes maintenance of insufflation pressures difficult resulting in inadequate visualization throughout the procedure. This method also requires the use of a larger trocar thereby posing a risk of postoperative herniation at that site despite the best attempts at fascial closure.

In the patient with a primary ventral hernia or a single small defect, a Veress needle could be considered for insufflation before introduction of the first trocar. A "safe" area for needle insertion is usually in the right upper quadrant because it is generally free of adhesions of bowel and omentum. A site in the upper midline could also be used if it can be placed far enough away from the hernia so as not to interfere with the repair of the hernia.

Another method to gain access into the abdominal cavity uses an "optical" trocar for abdominal entry. These non-bladed trocars are designed to provide visualization of each layer of the abdominal wall as the trocar passes through them. This is accomplished because the laparoscope is inserted into the trocar, and these structures are seen as the trocar is passed. This is gaining in popularity (Figs. 28.1, 28.2, and 28.3).

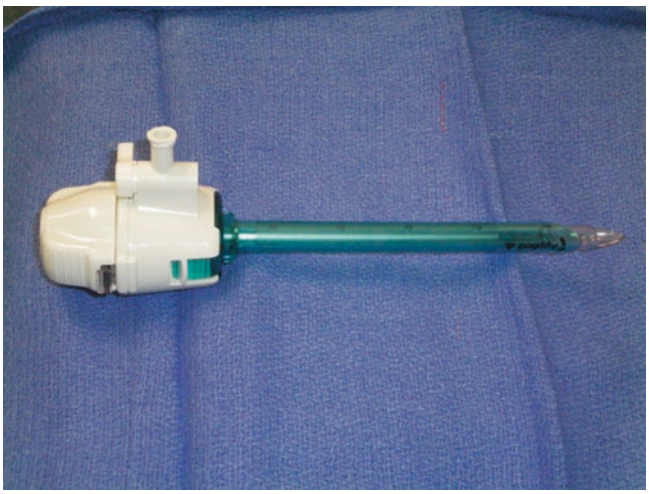

Fig. 28.1 A typical optical trocar with a clear non-cutting tip

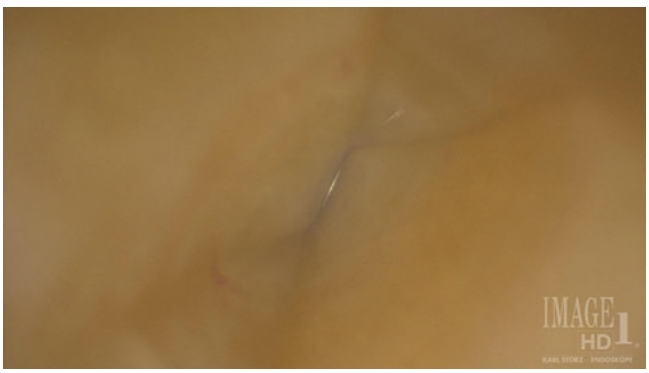

Fig. 28.2 View of subcutaneous layer through an optical trocar

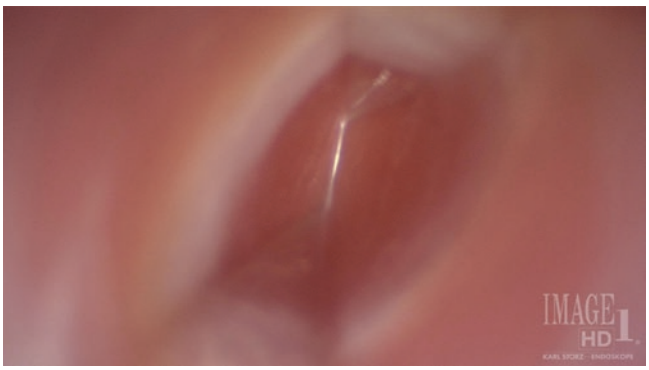

Fig. 28.3 Muscular layers seen as the optical trocar is passed into the abdomen

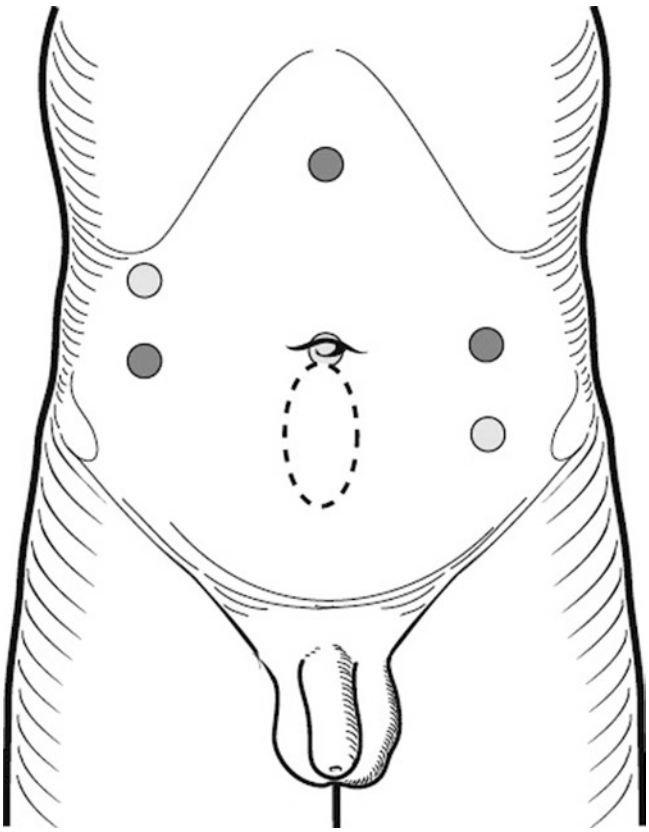

Fig. 28.4 Typical trocar positions for a lower midline hernia. The dark circles represent the location of the initial trocars. The upper midline trocar will accommodate the laparoscope. The other circles represent the location of additional trocars if these are needed to complete the procedure

In the majority of patients with an incisional hernia, the view of the abdomen is, at least partially, obscured by adhesions. To enhance visualization and to free up enough space for placement of additional trocars, blunt and/or sharp dissection of these adhesions is necessary. The primary goal after the insertion of each of the additional trocars will be placement of the final number of necessary trocars. After the insertion of each additional trocar, the laparoscope should be placed through it to inspect the abdomen. The new view that is afforded from that vantage point will identify the optimal location of the sites of the other trocars. Additionally, the collection of these different views is important to identify any bowel that may be at risk during adhesiolysis. This is extremely important because, in some cases, neither the surgeon nor the assistant will appreciate the proximity of the bowel from only the view that is available from an individual trocar position.

When determining the best locations for the trocar positions, the selection should avoid the problem of "mirror imaging" during the manipulation of the instruments from the side in direct opposition to the viewing laparoscope. This produces an image of any manipulation that is viewed from that port that is opposite the action taken. That is, a move of the laparoscopic instrument to the left will be seen as a move to the right and vice versa. Placement of the camera in the midline of the abdomen will avoid this problem (Figs. 28.4 and 28.5). An alternative is the insertion of an additional trocar on the ipsilateral side of the location of

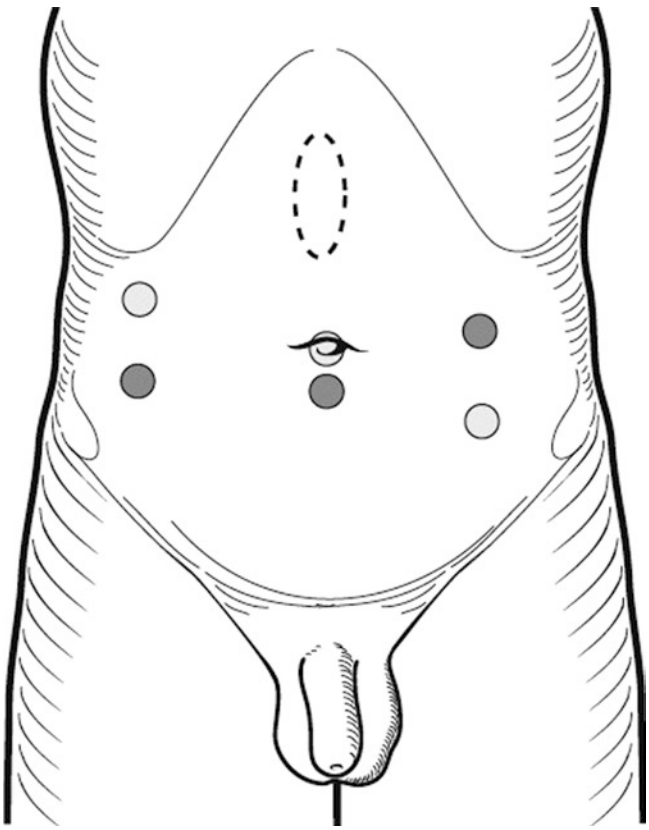

Fig. 28.5 Typical trocar positions for an upper midline hernia. The representations of the trocar sites mimic that of Fig. 28.4

the camera. With practice, many surgeons can overcome this technical problem without the use of additional trocars. Most of this difficulty can be eliminated if the assistant surgeon can use the instruments from his or her side of the patient. One should not hesitate to insert additional trocars when this problem cannot be corrected easily to ensure the safety of the operation.

Instruments

The choice of laparoscope (0, 30, or 45°) used for incisional hernia repair depends upon the familiarity of the operating team with the instruments, the planned position of the trocars, and the habitus of the patient. While the 0° laparoscope is the primary choice of this author, the majority of surgeons utilize the 30° laparoscope because it will allow good visualization of the undersurface of the abdominal wall. Additionally, one may view to the left and right of the operative field without changing the location of the optics. This is particularly beneficial in thin patients with firm muscle tone. The 45° laparoscope is seldom necessary for this operation. If the optics of the camera and system are optimal, the 5 mm laparoscopes will perform as well as do the 10 mm ones. A benefit of the smaller scopes is that they utilize smaller trocars, which diminish postoperative pain and minimize the risk of herniation at the site of the trocar.

The most significant and potentially fatal complication of laparoscopic incisional herniorrhaphy is an injury to the bowel. This will occur during the dissection of the adhesions that are frequently encountered. The method of dissection is critically important in order to minimize the risk of injury to the intestine. If the adhesions encountered are few and rather filmy, one may use the scissors with the additional application of electrocautery. This should only be done if there is absolute certainty that there is no bowel adjacent to the area that will be affected by the lateral extension of the electrocautery burn. The transection of the falciform ligament is an example of this situation. In most patients, dissection of omentum and/or bowel from the abdominal wall will be required. Multiple devices are available that limit the lateral spread of heat. Though these devices may be used for adhesiolysis, this should not allow the surgeon to become complacent in the use of an energy source within the abdominal cavity. The use of any type of an energy source can result in an injury to the intestine if used improperly. It is recommended that if the intestine is densely adherent to the abdominal wall or to a mesh from a prior failed repair, the use of scissors without cautery should be preferred. It is sometimes felt that the open procedure has less risk of intestinal injury compared to the laparoscopic approach because of the dissection of the intestine. Research does not show this to be true [28]. The risk of bowel injury is generally 1.78% and cannot be absolutely avoided. One needs to ensure that the dissection proceeds in as safe a manner as surgically feasible.

Not uncommonly, the hernia contents are known to be incarcerated preoperatively and cannot be reduced with dissection and traction. In such cases, the fascial defect must be enlarged to allow reduction of the involved organs. Electrocautery scissors are used if the fascia is thick. Sometimes the ultrasonic dissector will be sufficient to cut the tissue, but this is infrequent. Generally, a 2 or 3 cm incision into the fascia will suffice. The size of this incision is not that important because the resulting defect size will be covered by the prosthesis.

Prosthetic Biomaterials

There are currently many different products that are available for the repair of incisional hernias. The unprotected polypropylene and polyester biomaterials are prone to adhesion formation and pose a significant risk of fistulization. Most surgeons will choose a biomaterial that has been manufactured with some method to shield the intestine from coming into direct contact with the base material. There are expanded polytetrafluoroethylene products or composites of these materials available as well. These products are described in detail in Chap. 7.

Adhesiolysis and Identification of the Fascial Defect(s)

Before insertion of the prosthesis, the entire fascial defect(s) must be uncovered (Fig. 28.6). This usually requires removal of all the adhesions (Fig. 28.7) within the abdomen especially those attached to the anterior wall. It is best to dissect all of the adhesions that may potentially interfere with the appropriate positioning of the prosthetic material. It is also important to ensure that the parietal surface of any prosthetic material is in direct contact with the fascia and not with adipose tissue or omentum. Any fatty tissue that is interposed between the abdominal fascia and the prosthesis will inhibit the appropriate ingrowth of tissue and subsequent incorporation of the biomaterial. A technical problem can develop if all of the adhesions are not adequately removed in the area of the final location of the prosthesis. If it becomes apparent that the adhesions are inhibiting the final attachment of the mesh, then the procedure must be temporarily delayed to

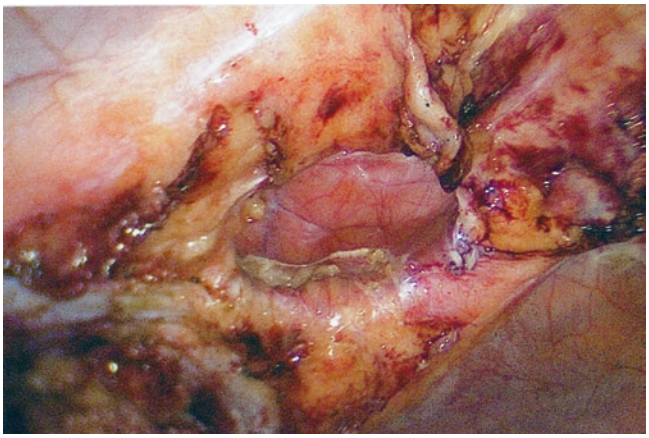

Fig. 28.6 Laparoscopic view of fully dissected incisional hernia (note the preperitoneal fat has been removed to expose the fascia)

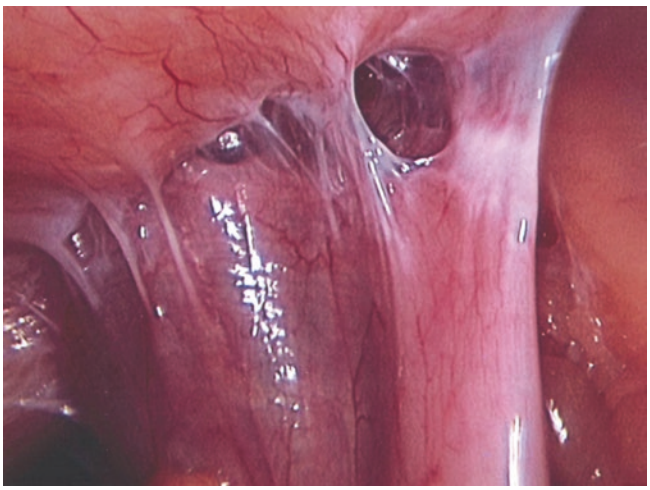

Fig. 28.7 Typical adhesions of the small intestine that require dissection from the abdominal wall

allow for the additional adhesiolysis. This process can be particularly difficult once the prosthesis is partly attached to the abdominal wall, hampering visualization and further dissection. With this in mind, it should be noted that it is particularly important to dissect the falciform ligament or lower abdominal preperitoneal fat to expose the fascia adequately.

Dissection of the hernia sac is difficult and can result in bleeding while not producing any appreciable benefits for the patient. Therefore, it is not necessary to remove it. Some surgeons apply electrocautery or argon beam to the site of the peritoneal lining of the hernia sac in an effort to obliterate it and thereby reduce seroma formation. It is not known whether this has the desired effect. Closure of the fascial defect is not routinely performed, though some promote routine fascial closure during LIVH [23]. There is a growing opinion that this should be done when feasible, although this will be limited by the size of the defect. The security of the hernioplasty depends upon an adequate overlap of the fascial defect by the prosthesis and adequate patch fixation. It does appear that closure of the defect will reduce seroma rates in most but not all reported series [29–32]. Others have reported either no benefit or an increase in adverse outcomes with defect closure [33, 34].

It is essential that the measurement of the hernia defect is accurate. This size of the defect will determine the size of the prosthetic. If this measurement is performed with the abdomen fully insufflated, the resulting size determination will be artifactually larger than the proper measurement. The size of the defect must be measured with the insufflation pressure reduced from the working amount of 14–16 mm Hg to near zero. Reducing the pressure prevents the inflation artifact that occurs because this measurement is done on the external surface of the abdominal wall rather than on the interior surface. After desufflation, the defect is outlined on the skin over the abdomen with a skin-marking pencil (Fig. 28.8). If the choice of prosthetic size is made based on the measurement in the insufflated position, it is likely that the prosthesis will be much larger than is required. Use of that material can be exceedingly difficult because some of the trocar sites can be covered with the biomaterial. One must then trim the patch as it lies within the abdomen, which is cumbersome. The entire circumference of the defect should be identified to ascertain its maximum dimensions. To ensure adequate coverage with the prosthesis, a minimum of 5 cm is added to the maximum measurements in all directions. In other words, if the defect were 7 × 12 cm, the minimum patch size would be 17 × 22 cm. Current thought is that a 5 cm overlap is ideal [35]. Recent evidence suggests that using overlap alone is insufficient to properly size the mesh [36]. In this study, the mesh-to-defect (M/D) ratio was used to size the mesh. It was determined that a M/D ratio of 13 or larger resulted in a recurrence rate of 4% with a <5 cm mesh overlap and a 1% recurrence rate if the overlap was 5 cm or greater. The authors of this paper, that with larger hernias, the laparoscopic approach may be insufficient to cover the defect appropriately.

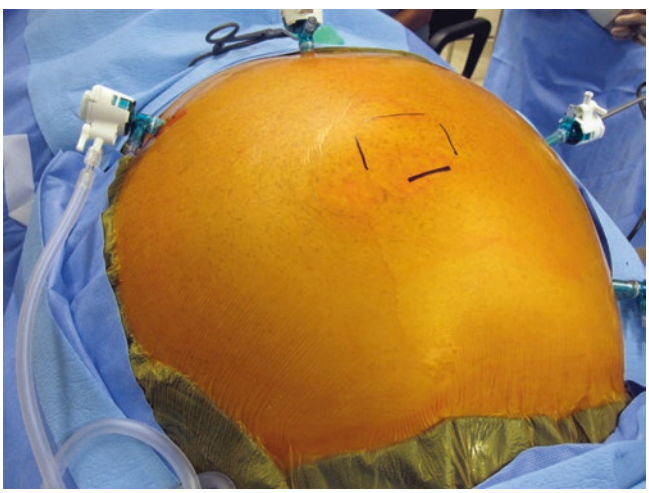

Fig. 28.8 Skin marks placed to identify the edges of the fascial defect

The choice of the prosthesis will be made based on the available sizes that are manufactured. In many cases, this will provide coverage in excess of 5 cm requirements. This is felt to be advantageous. If the patient is morbidly obese, it is preferred that a larger overlap disperses the intra-abdominal pressure over a larger surface area to diminish the risk of recurrence. We also believe that it is preferable to cover the entire length of the original incision even though only a portion may have an actual hernia defect. This will avoid the future occurrence of a hernia either above or below the actual repair of the original hernia. Several different techniques may be used before patch insertion to ensure that the prosthesis will be oriented properly and cover the defect adequately. One approach is to tie ePTFE sutures (CV-0) at either side of the midpoint of the long axis of the patch and mark both sides of the midpoint of its short axis with a marking pencil prior to its insertion into the abdominal cavity [37]. It is important to mark both sides of the midpoints of the prosthesis (Figs. 28.9 and 28.10). This can be done with a marking pencil if this is possible to do so; if the biomaterial does not allow this, then one may mark these points with sutures. Once the prosthetic is inserted, the surgeon will need to visualize both surfaces of the biomaterial to assure the correct axial orientation along the abdominal wall. Some surgeons mark the short axis by placement of a contrastingly colored nonabsorbable suture, such as Prolene® or Ethibond®. Others place four or more sutures at the corners or periphery of the patches prior to insertion. The more sutures that are placed into the prosthesis prior to insertion, the more likely that there will be a tangle of suture material that can be cumbersome to separate and pull through the abdominal wall. The use of sutures in this repair

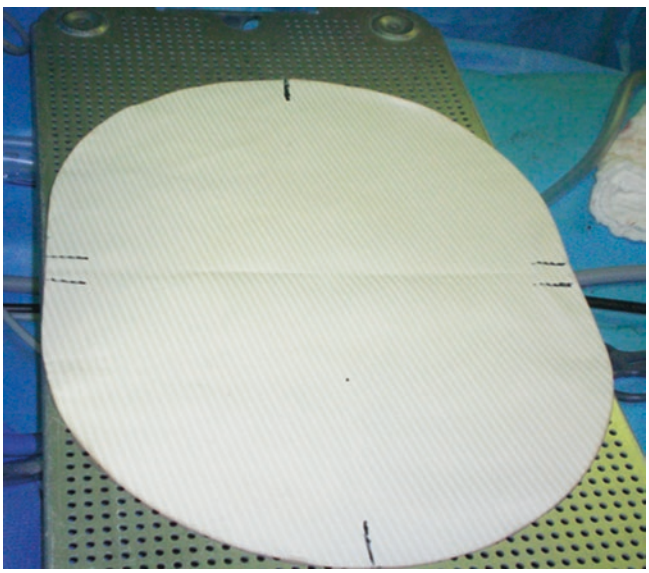

Fig. 28.9 Marks place to identify the midpoints of the parietal surface of DualMesh Plus

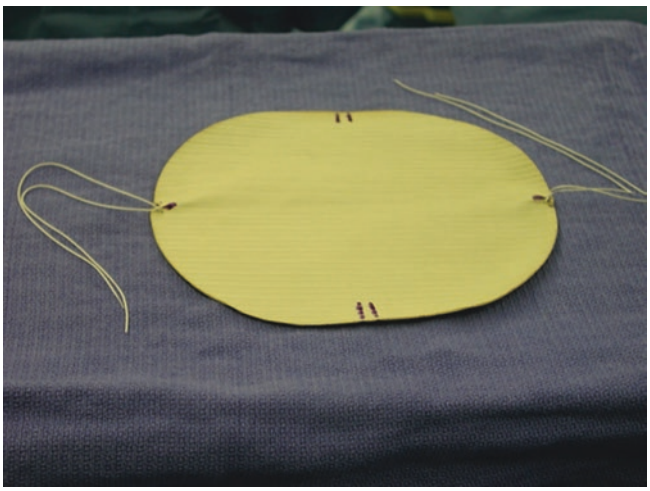

Fig. 28.10 Initial two ePTFE sutures placed at the midpoints of the long axis of the prosthesis

continues to be discussed. Some surgeons do not believe that transfascial sutures are necessary [38], but others feel that this is absolutely indicated [37, 39, 40]. Data on prostheses and the final decision on the use of sutures will continue to evolve. It seems that if the overlap is 5 cm or greater, then transfascial sutures can be omitted [41]. However, many surgeons, the author included, believe that the benefit of the sutures out ways the risk of the few patients that may develop pain postoperatively. In certain instances, such as hernias distant to bony prominences, tacking alone may be sufficient [42].

The patch with any attached sutures is rolled or folded for introduction into the abdomen. The method of folding the patch is simplest if the material is folded into sequential halves after the prior fold [37]. As shown in Figs. 28.10, 28.11, 28.12, 28.13, and 28.14, the sutures are placed into the first fold, and the subsequent folds result in a smaller size of the biomaterial. Early in the learning curve, it is suggested that 10 or 12 mm ports be utilized to insert the patches. As experience is acquired, one will find that the use of only 5 mm trocars will often suffice. Some of the prostheses that are available today, such as the polypropylene- or polyester-based biomaterials, require the use of the larger trocars for their insertion into the abdominal cavity. With those products that can be compressed adequately, such as DualMesh® Plus (which is 50% air by volume), one can pull them into the abdomen with the use of the 5 mm ports. In these instances, the skin incision at the site of patch introduction should be made larger than that which is necessary for placement of the trocar itself (typically 7–8 mm). Generally, particularly for the larger patches, a grasping instrument is passed through a trocar on the opposite side of the abdomen, which is then passed outward through a trocar on the other side. The trocar through which the instrument is exited is then removed

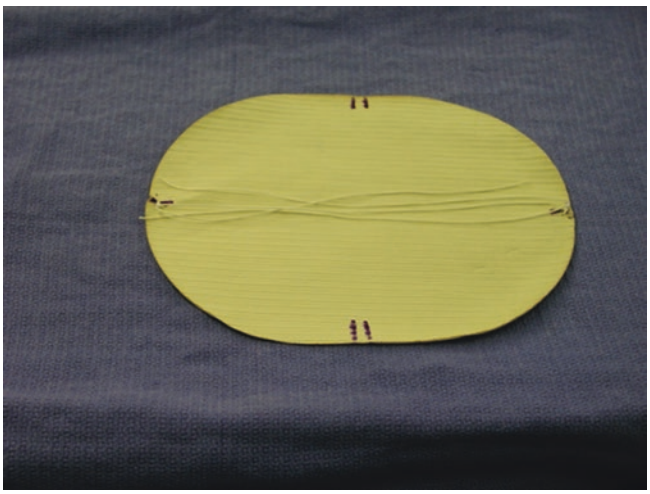

Fig. 28.11 These initial sutures are placed on the parietal surface prior to folding the mesh

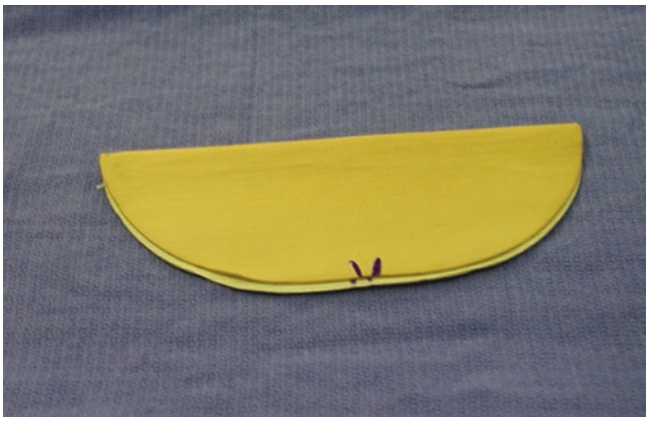

Fig. 28.12 The first fold of the prosthesis encloses these sutures (note that the edges of the mesh are offset from each other to make it easier to grasp them intraperitoneally after introduction)

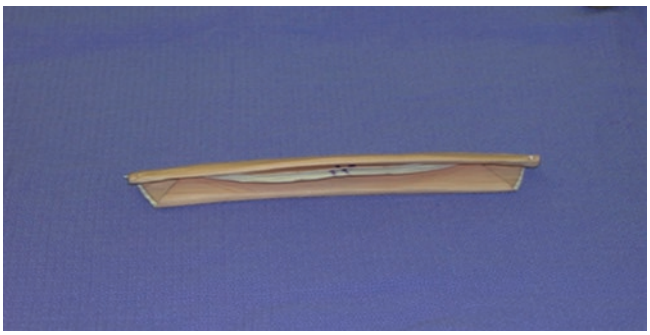

Fig. 28.13 The second fold of the mesh is shown

(Fig. 28.15). The tightly rolled and/or twisted biomaterial will be grasped by the instrument and pulled into the abdominal cavity (Figs. 28.16 and 28.17). The assistant surgeon can assist this maneuver by maintaining the "twist" of the patch as it is introduced. The pliability of the abdominal wall musculature will accommodate the insertion of even the largest

Fig. 28.14 After the folding, the product will be tightly rolled to ease introduction

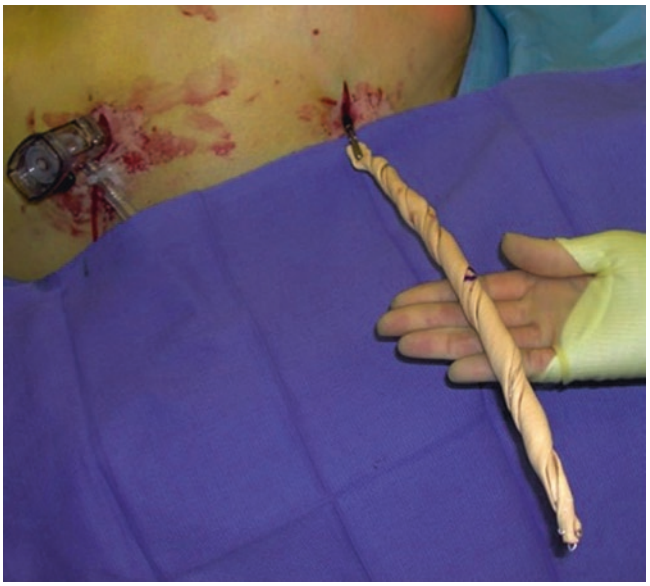

Fig. 28.15 A grasper is put through a trocar, which is then removed. The instrument will grasp the mesh and then pull it into the abdominal cavity

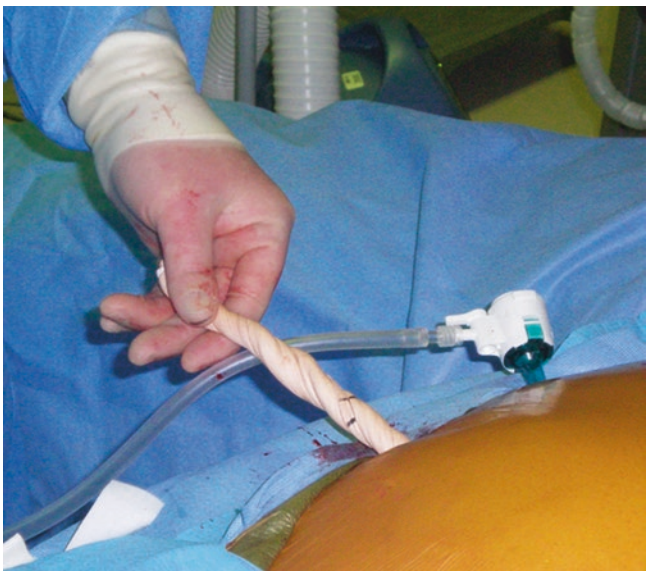

Fig. 28.16 External view of the mesh as it is pulled into the abdomen

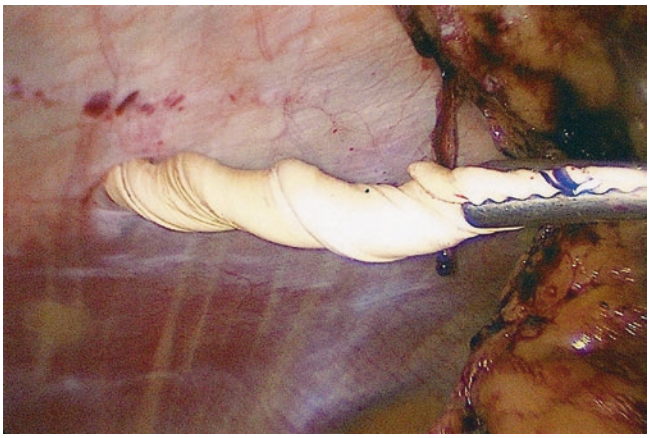

Fig. 28.17 Laparoscopic view of the mesh as it is pulled into the abdomen

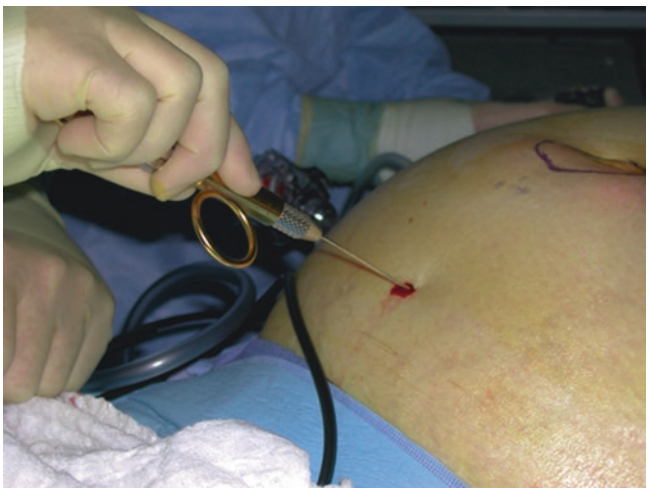

Fig. 28.18 Suture passing instrument has been introduced to grasp one of the initial two sutures

of the ePTFE patches available (24 × 36 cm). This maneuver can, of course, be duplicated with other meshes and the larger trocars. If the larger trocars are used, however, the smaller patches can frequently be inserted directly through the trocar rather than by the above method.

Placement of the Prosthesis

After insertion, the patch must be returned to its original flattened shape. The biomaterial is placed onto the viscera whereupon the surgeon and the assistant will then assist each other in the manipulation of the biomaterial to completely flatten it as much as is feasible. This will facilitate the fixation of the material to the abdominal wall. If this is not possible, it may be easier to unroll the prosthesis after one or both of the initial sutures have been passed through the abdominal wall. It is preferable, however, to do this only if the above method fails because the maneuverability of the prosthesis will be impaired once the fixation is initiated.

If a single central suture is used, this will be drawn through the abdominal wall in the center of the fascial defect. If one has chosen to use only two initially placed sutures, these are now pulled through the entire abdominal wall with use of a sharp suture passing instrument inserted through a small skin incision (Fig. 28.18). There are several different devices that are available for this purpose. These two sutures are placed along the long axis of the defect taking care to center the prosthesis over the defect. If necessary, the laparoscope can be placed into another port to confirm that it is centered with the necessary 5 cm minimum overlap and drawn tautly. If these two facts cannot be confirmed, then one or both of these sutures must be repositioned. This is critical because "mesh shift" has been identified as a source or recurrence [43]. Once the optimal position is achieved, the sutures are tied. Even in large patients, the knots can usually be pulled down to the level of the fascia. It is important to make sure that these and all the subsequent sutures are tied sufficiently tight to pull them to the fascia without any laxity. It is sometimes necessary to enlarge the skin incision slightly to allow the surgeon enough room to properly tie the suture down to the fascial level. An additional method of confirmation will be simply to examine each suture laparoscopically once tied or at the completion of the entire procedure. If the suture is loose, then it must be cut and replaced.

The next step will be to confirm that the correct orientation along the short axis of the patch is correct. The surgeon and the assistant will grasp the previously marked midpoints on either side of the biomaterial. The material is then positioned over the desired final location. Either the assistant or the surgeon then uses a fixation device to attach the midpoint of one side placing only one or two tacks at that time. The tacking instrument is then given to the other surgeon, and the unattached midpoint is likewise secured with one or two tacks. Inspection of the position of the biomaterial is again performed usually by moving the laparoscope to one of the other trocars to visualize the position of the biomaterial from different angles before the insertion of the additional tacks and sutures that will permanently secure the patch. After this inspection, the tacks are deployed along the periphery of the prosthesis by inserting them 2–4 mm from the edge of the patch, 1–1.5 cm apart (Fig. 28.19) [37]. Multiple tackers are available for use in both permanent and absorbable configurations (see Chap. 7).

Several authors have identified the need to place transfascial sutures to ensure adequate fixation of the biomaterial [37, 39, 44, 45]. It is generally believed that the insertion of the tacks is merely an initial step and serves mainly to approximate the prosthesis to the abdominal wall to ensure adequate tissue ingrowth. In one study, the rate of hernia recurrence without the use of these transfascial sutures

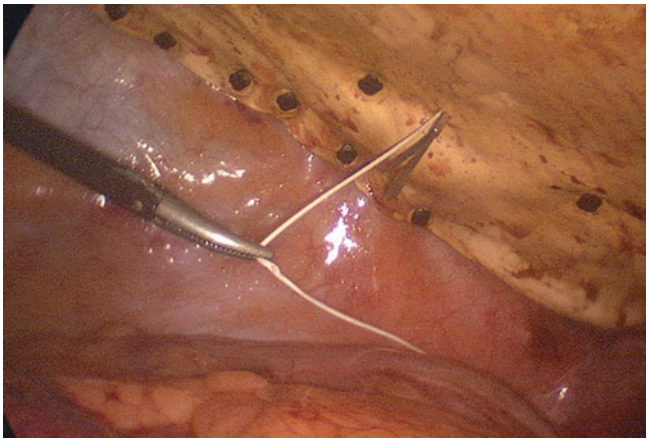

Fig. 28.19 The laparoscopic instrument has grasped an additional suture from the suture passing instrument

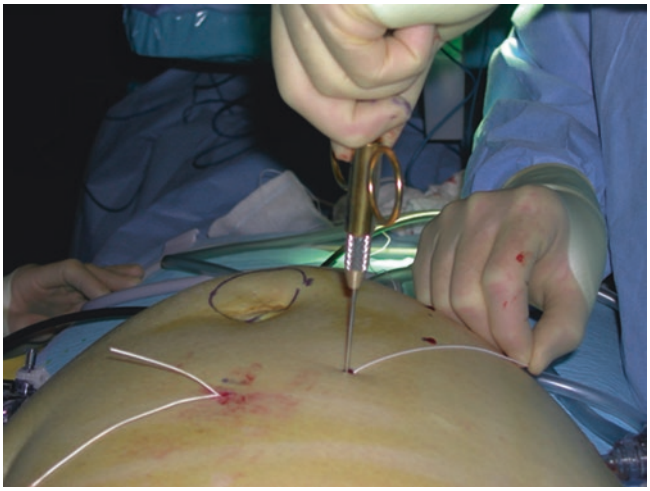

Fig. 28.20 External view of the suture passer retrieving a suture from the abdomen

resulted in a recurrence of 13%, while there were no recurrences seen in those patients that had the use of sutures [44]. A recent meta-analysis showed that the degree of overlap can influence the need for transfascial sutures. Generally, in some hernioplasties with a 5 cm overlap, transfascial sutures may not be needed [41]. Tacking is followed by placement of nonabsorbable sutures (e.g., ePTFE) of size 0. These sutures will be placed through all musculofascial layers of the abdominal wall and tied above the fascia in a manner similar to the tying of the initial two sutures. This method is reported to be preferred to minimize recurrence risk [18]. During the insertion of the sutures, one should avoid clamping of any portion of the suture material that will remain within the patient. If this occurs, the suture will be permanently weakened and may fracture at that site which can lead to failure of the suture and a recurrence of the hernia.

Using the view of the laparoscope, the planned sites of suture placement are marked at intervals of 5–8 cm apart. A mark is made with the skin-marking pen at these points whereupon a no.11 scalpel blade is used to make a 1–2 mm skin incision at each of these points. Then at each site a suture is passed through the skin incision with one of the many fascial closure or suture passing devices that are available (Fig. 28.20). The suture passer pierces the patch at the appropriate place. The assistant (from the opposite side of the abdomen) retrieves the suture with a grasping instrument, and the suture is released (Fig. 28.21). The device is now withdrawn into the subcutaneous tissue and reinserted through the patch approximately 1 cm from the previous puncture site. The previously inserted suture is retrieved from the assistant and withdrawn from the abdomen onto the skin (Fig. 28.22). The two tails of the suture are grasped with a hemostat, and the suture is cut with sufficient length to allow for the tying of the suture. These maneuvers are

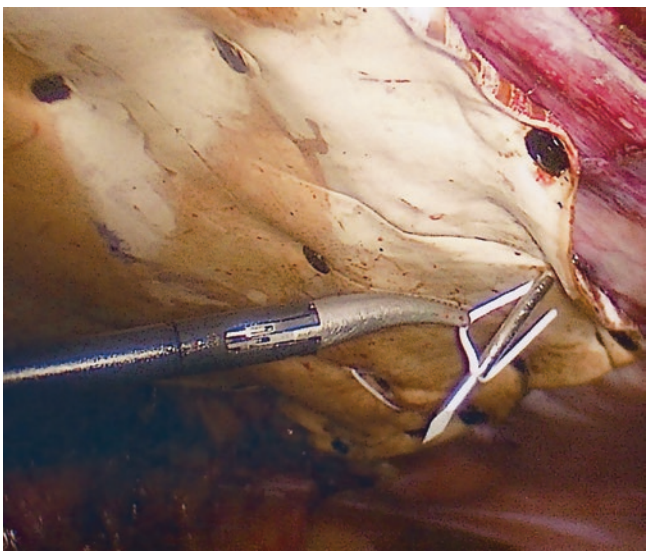

Fig. 28.21 Another view of the "hand-off" of a suture

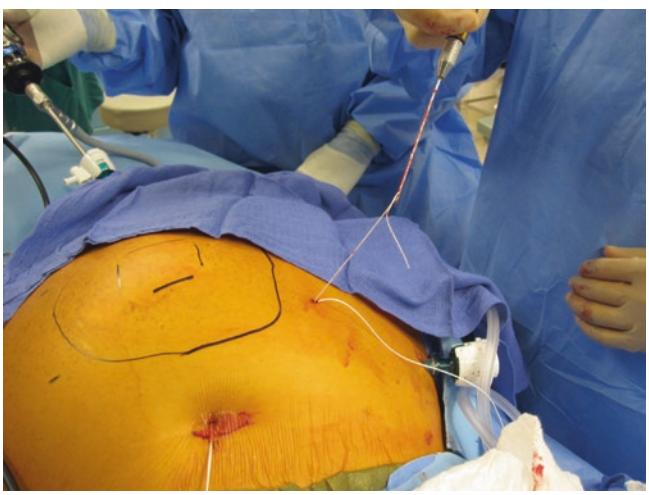

Fig. 28.22 Another view of suture retrieval

repeated then along the entire edge of the patch (Fig. 28.23). Once the sutures are tied, the patch should lay flat and obliterate the fascial defect. A final examination of the prosthetic is performed to insure that all sutures are tight and that all edges of the patch are secured (Fig. 28.24). Any laxity of the sutures will require that these be replaced with others that provide sufficient fixation without looseness.

When the sutures are tied down, a dimple of the skin may develop at the site of the incision where the suture has been passed. This is caused by the fixation of the subcutaneous tissue that may have been grasped by the knots of the suture. This dimple can be removed by placing a fine pointed hemostat into the incision to lift the skin away from the suture (Fig. 28.25). It is important to inspect the abdominal wall with the abdomen fully insufflated after the completion of the suture fixation so that any dimples are removed. If this is not done, the cosmetic result will be unacceptable to the patient.

Rather than placing the additional sutures as described above, in some centers, an additional row of fasteners is placed near the fascial edges. The result is two concentric rows of tacks that secure the prosthesis. This "double-crown" technique is popular in some centers [38]. Current follow-up data appears to be favorable, but longer-term data will be necessary to verify its effectiveness.

After the removal of the trocars and closure of the skin incisions, an abdominal binder is frequently used and left in place for at least 72 h. It is preferred, however, if the use of this binder could continue for 4–6 weeks. It is believed that the use of this binder aids in the prevention of a postoperative seroma at the site of the hernia. It assists in the management of postoperative pain and does not appear to affect the respiratory effort of the patient.

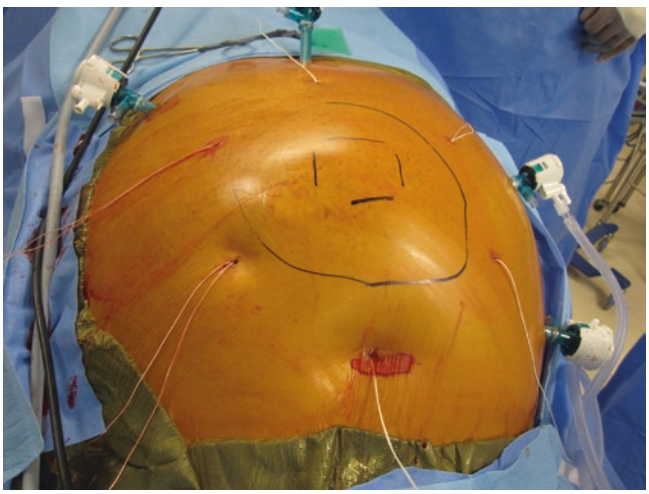

Fig. 28.23 Completed passage of the transfascial sutures

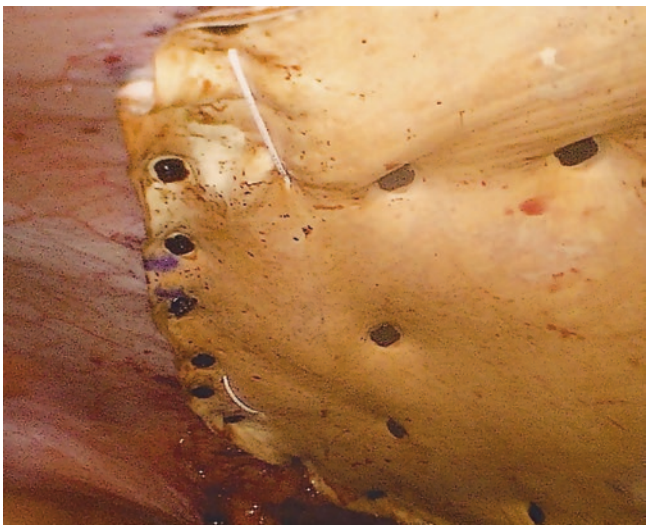

Fig. 28.24 Laparoscopic view of the completed fixation of the prosthesis with sutures and fasteners

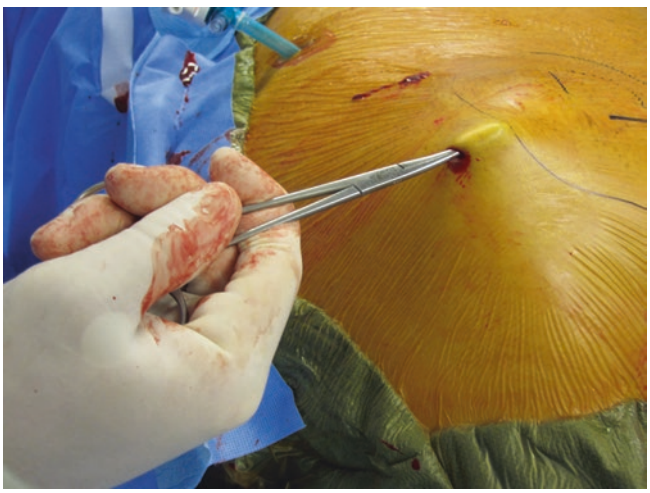

Fig. 28.25 Use of a hemostat to release the subcutaneous tissue from the suture to remove skin puckering

Immediate Postoperative Considerations

Approximately 50% of these patients can be discharged on the same day of surgery. Generally, this will be the patient that has a single defect, a hernia dimension of less than 25 cm^2 [1], few adhesions, and no incarcerated contents of the hernia. The average length of stay is 1–2 days [6, 7, 11]. Patients can consume liquids the day of surgery and resume taking any regular medications immediately. Oral and parenteral sedatives are given as needed. Postoperatively, many patients will experience some degree of abdominal distension, which is usually proportional to the extent of adhesiolysis and the extent of bowel involvement. However, most patients can resume a regular diet the day after the operation. Occasionally, some patients will experience prolongation of

the ileus. This should be managed by the usual methods, which would include a nasogastric tube when necessary.

Pain may be used as the guide to determine when patients can resume their normal activities. They are allowed to shower the next day. Patients may return to their daily activities, including work, as soon as they can do so without marked pain. The majority of patients are able to drive within a week and resume job-related activities in 7–14 days. Most surgeons do not restrict the activities of these patients but allow the level of pain to dictate the increase in the level of activity.

After removal of the binder, many patients will note a firm bulge at the hernia site. The bulge may represent a seroma in the first few weeks, but subsequently this area represents the cicatricial event that occurs in the majority of these patients. Seroma formation is a common occurrence after LIVH. However, it is rarely, if ever, necessary to aspirate these fluid collections, as they will generally resolve without intervention. Aspiration will also expose the patient to a risk of the introduction of infection into the seroma.

Late Postoperative Considerations

In most patients with the cicatricial "bulge" and/or seroma at the hernia site, resolution will be noted within 2 months, depending on the size of the hernia and its contents. Occasionally the skin of the abdominal wall that overlaid the hernia will become erythematous within 4–6 days postoperatively, usually in association with a distinct surface firmness but with little tenderness and without the presence of fever, chills, or leukocytosis (Fig. 28.26). This situation, which is seen in approximately 5–7% of patients, can persist for a few weeks and can be most unsettling. This is believed to be the result of resorption of fatty tissue or the hernia sac that was left in place during the initial operation. This appears to be particularly common after the repair of hernias that had minimal soft tissue between the skin and peritoneal sac and/or a significant amount of incarcerated tissue. No treatment is necessary unless there is a strong suspicion of infection.

Usually within 2–3 months, the abdominal wall will have completed its postoperative changes (Figs. 28.27 and 28.28). Infrequently, an apparent seroma can still be felt. Ultrasonography or CT scan could evaluate this finding if there is a concern regarding the possibility of a recurrence of the hernia.

In less than 2% of patients, prolonged pain (>3 months) at the site of the transfascial sutures will occur [46]. Usually this can be treated effectively with nonsteroidal anti-inflammatory drugs or direct injections of xylocaine or other local anesthetic [47]. If this problem persists despite these maneuvers, the surgeon might consider performing a laparoscopic examination to inspect the patch, tacks, and sutures. This is rarely necessary, but occasionally transection of the offending suture will be necessary to effect a permanent relief of these symptoms.

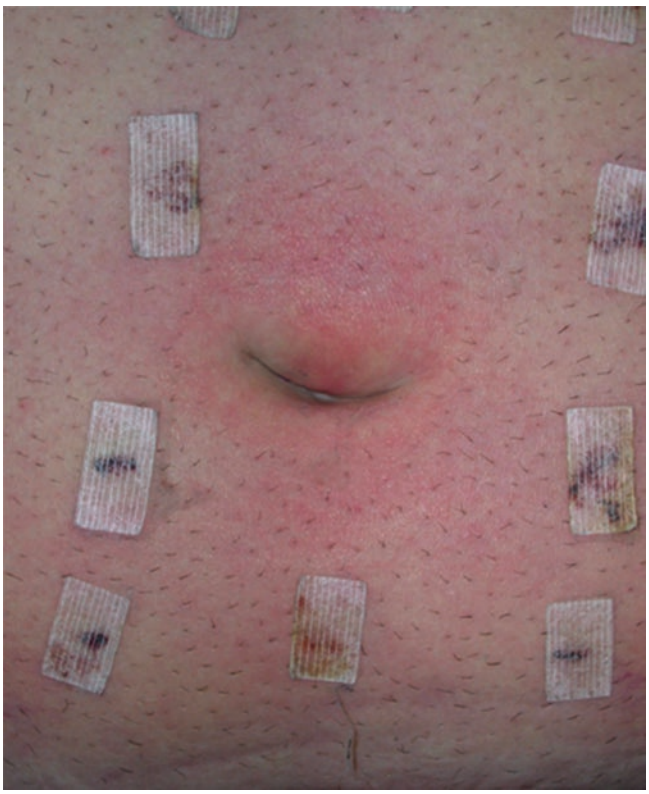

Fig. 28.26 Postoperative appearance of erythema that is not abnormal and noninfected

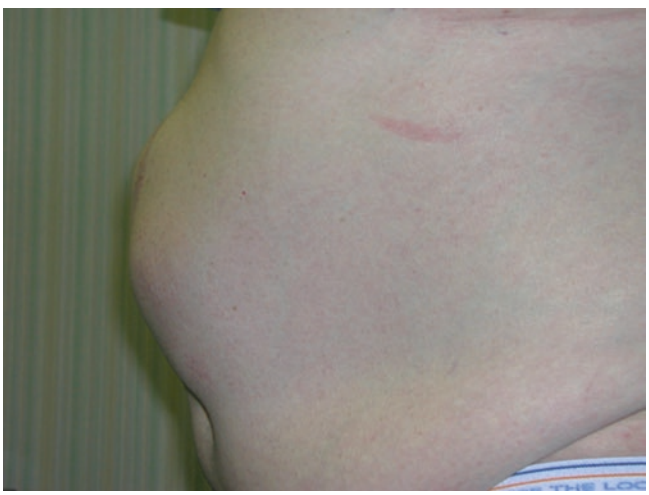

Fig. 28.27 Preoperative appearance of a large incisional hernia following a trauma laparotomy

Hernioplasty of Infrequent Defects

The majority of incisional and ventral hernias will occur in the midline of the abdomen. One will encounter other hernias that offer a particular challenge whether repaired by the open or the laparoscopic technique. One such hernia is that which lies very high in the midline, perhaps at the exit site of a mediastinal drainage tube used for open-heart surgery.

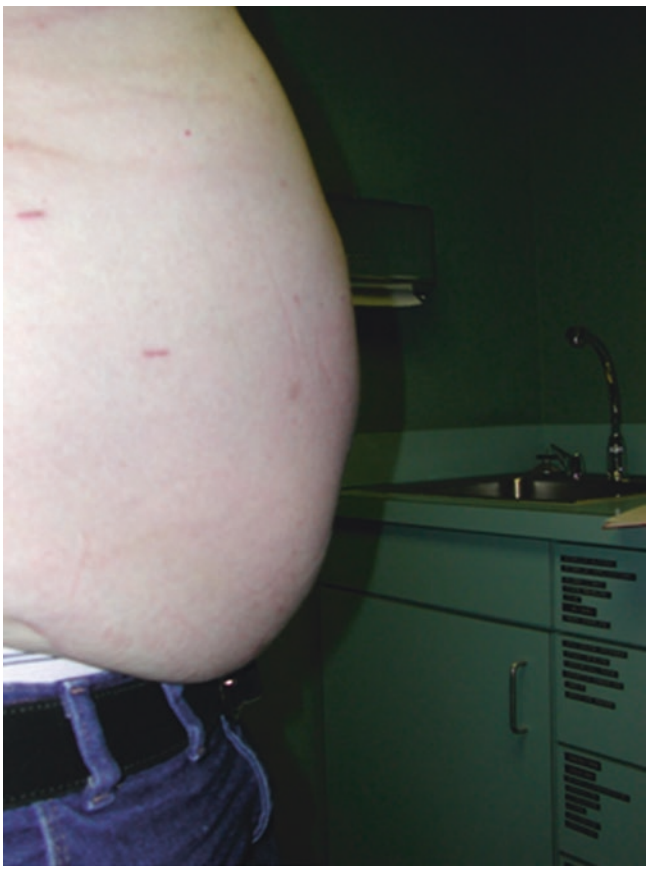

Fig. 28.28 Postoperative appearance of the same patient in Fig. 28.27 3 months after LIVH

Repair of this defect may require that the prosthetic patch be placed near or onto the diaphragm. It may be impossible to achieve an adequate amount of counter pressure necessary for the tacking device to provide adequate penetration of the tacks. For a defect in the pericardial area, it is advisable to use only sutures to secure the patch in order to avoid penetration of tacks into the myocardium or development of pericarditis requiring removal of the tacks [48]. There have been anecdotal reports and unreported events of cardiac penetration and tamponade with the use of fasteners other than sutures this high in the abdominal cavity. In this situation, nonabsorbable sutures should be placed. Additionally an oversized patch is recommended to provide a greater overlap (8 cm or greater) than usually required due to this fixation problem.

Hernias that extend to the symphysis pubis or are associated with an inguinal hernia can also present a challenge. To repair these defects, it will be necessary to attach the lower part of the patch to Cooper's ligament. To accomplish this, it will be necessary to dissect the preperitoneal space similar to the laparoscopic transabdominal preperitoneal inguinal hernia repair. This must be done to provide for strong fixation of the patch to the muscle wall of the lower abdomen and the periosteum of the pubis because transfascial sutures cannot be placed in this location. Additionally, interposing preperitoneal fat and peritoneum that remains between the patch and muscle will compromise subsequent tissue attachment. After the patch is secured, the preperitoneal flap can be secured in its usual position to the maximum extent possible, if desired.

Incisional "hernias" that occur after nephrectomy or an anterior approach to the spine are usually not true hernias as they generally do not exhibit a well-defined fascial defect. The repair of these deformities is not currently established in the literature. Surgeons that do attempt to repair these deformities must pay particular attention to the positioning of the patient. Patients with such defects should be placed in a lateral decubitus position on a "beanbag." Defects along the upper flanks that involve denervated musculature rather than a true fascial lesion require a very large patch that is secured tightly with more than the usual number of sutures to achieve an acceptable cosmetic result. The laxity of the muscles will frequently require that sutures be placed above the rib margin to secure the prosthetic biomaterial. Additionally, one may need to place sutures onto the diaphragm to ensure fixation. It is may be necessary to place additional trocars through the biomaterial itself (Fig. 28.29) to allow for the accurate placement of all the methods of fixation. In my series of patients with this repair, the results are good, but I have found that the hybrid repair described below is preferable to the purely laparoscopic method.

Hybrid procedures may be necessary for complex hernias such as the above or for patients with significant adhesions. The hybrid procedure combines open and laparoscopic techniques to achieve adequate overlap of the defect and safe adhesiolysis. Often for denervation hernias that occur after lumbar surgery, the initial muscle mobilization can be performed through the original lumbar incision.

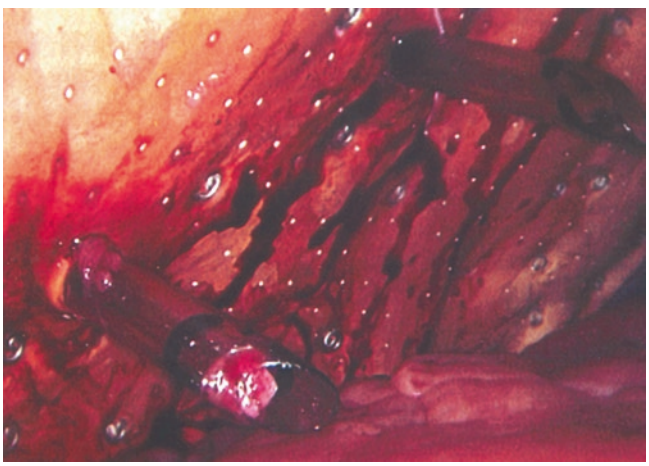

Fig. 28.29 Trocars placed through a prosthesis to place fasteners on the medial aspect of this repair

The prosthetic of choice is placed in the abdomen after mobilization of viscera and lysis of adhesions. Transfascial or tacking sutures, such as to the diaphragm, can be placed during the open portion of the procedure. Trocars are then placed under direct vision. After the mesh is secured appropriately, the muscle layers can be plicated, an onlay mesh is placed, and the skin is closed. The abdomen is then insufflated, and laparoscopic suturing and tacking can be performed for adequate overlap and adherence to the abdominal wall (Figs. 28.30 and 28.31). This type of procedure has been reported in a small series of patients with 1-year follow-up and no evidence of recurrence [49]. In my own series with longer than a 4-year follow-up, no recurrence has been noted. In most patients, there will always be an amount of asymmetry compared to the opposite side due to the lack of musculature tone of the denervated muscle.

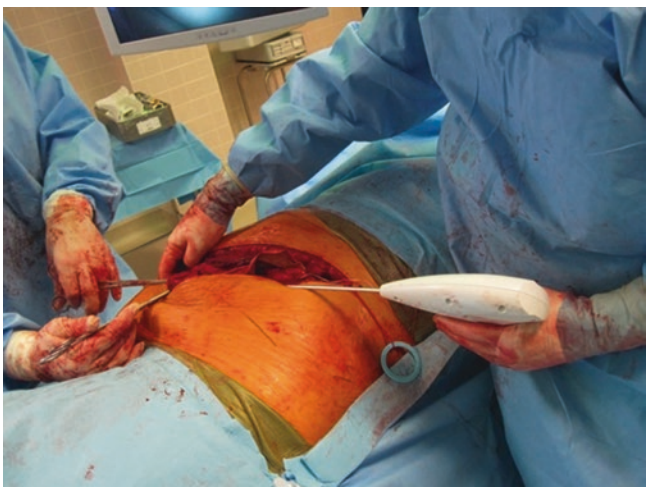

Fig. 28.30 Use of laparoscopic fixation device during the open portion of the hybrid procedure

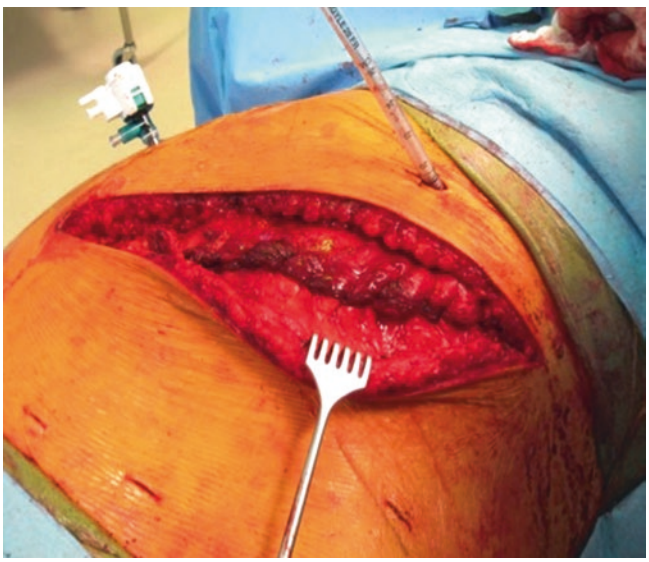

Fig. 28.31 Completed open portion of hybrid procedure with laparoscopic trocars in place

Many patients who present for laparoscopic incisional hernia repair may also require surgical treatment of a concomitant illness. This most commonly will include cholelithiasis, inguinal hernia, gastroesophageal reflux disease, or a need for biopsy of an intra-abdominal or retroperitoneal structure [44, 50]. Most commonly, the primary procedure is not the incisional hernia repair and, as such, will be performed initially. If the primary operation can be completed without contamination, the hernia repair could then be performed. If contamination does occur, a prosthetic hernia repair may or may not be done. This will be dictated by the amount of contamination and the risk of infection. An open repair such as a component separation or primary repair with or without a mesh could be considered but should be individualized to the patient's risk factors, prior operations, and/or prior hernia repairs. Preoperative discussions with the patient should have examined this possibility. In those individuals in whom the hernia repair can be attempted subsequent to the primary procedure, placement of additional trocars may be necessary. The surgeon could plan on the future trocars at the initiation of the primary procedure but should not compromise the first procedure by the inappropriate positioning at that point. Any additional necessary trocars should be placed in the locations most appropriate for the hernioplasty once the decision is made to proceed with the second procedure. One should not avoid using more trocars when deemed necessary to carry out the second operation in a safe and effective manner.

Results

In the past decade, there has been a significant amount of literature comparing LIVH to open mesh repair including four prospective trials, three retrospective trials, and multiple meta-analysis and review papers (Table 28.1). Yet the literature fails to provide a standardization of technique in open mesh repairs. The Rives-Stoppa repair has a known recurrence rate ranging from 0 to 14% [54]; however, Burger described a recurrence rate of 32% in open mesh repairs [5]. The majority of laparoscopic repairs described in comparative trials [6, 8, 9, 11, 51–53] do adhere to the basic tenets of LIVH which include 3 cm or greater mesh overlap and both transfascial sutures and tacks for mesh fixation as promoted by LeBlanc and colleagues [55]. This discordant approach to open mesh repair has challenged a true comparison to LIVH in terms of overall recurrence rates.

Pring and colleagues attempted to standardize their technique by using ePTFE as an underlay with transfascial sutures in both open and laparoscopic repairs. Their results yielded a recurrence rate of 4.2% for open mesh repairs and 3.3% for laparoscopic repairs; this recurrence

Table 28.1 Comparison of recurrence rates, post-op stay, and OR time

	Study type	Year of publication	Recurrence rates		Post-op stay (days)		OR time (min)		Follow-up	
			Open	Lap	Open	Lap	Open	Lap	Open	Lap
Ballem [51]	Retrospective	2008	28%	29%	–	–	–	–	7.5 years[a]	7.5 years
Bencini [52]	Retrospective	2003	6%	0%	8[b]	5[b]	112	108	18 months[b]	17 months[b]
Bencini [53]	Retrospective	2009	11%	14%	2[a]	3[a]	35	70	60 months[a]	56 months[a]
Olmi [9]	Prospective	2007	1.1%	2.3%	9.9[b]	2.7[b]	151	61	24 months[a]	24 months[a]
Pring [6]	Prospective	2008	4.2%	3.3%	1[a]	1[a]	43	44	27.5 months[a]	27.5 months[a]
Lomanto [8]	Prospective	2006	10%	2%	4.7[b]	2.7[b]	93	91	20.8[b]	20.8[b]
McGreevy [11]	Prospective	2003	–	–	1.5 [b]	1.1[b]	102	132	30 days[c]	30 days[c]
Forbes [10]	Meta-analysis	2009	3.6%	3.4%	–	–	–	–	6–40.8 months	6–40.8 months
Pierce [7]	Meta-analysis	2007	12.1%	3.1–4.3%	4.3[b]	2.4[b]	104.5	103	20.2[d]	25.5[d]

[a]Median
[b]Mean
[c]Completed length of follow-up
[d]Unspecified

rate was not statistically different [6]. A meta-analysis performed by Forbes et al. reviewed eight randomized controlled trials [10]. A similar study was done by Sajid et al. on five randomized controlled trials, and Sains and colleagues reviewed five comparative trials [56, 57]; all of these meta-analysis report no statistical difference in the recurrence rate between LIVH and open mesh repair. One of the largest meta-analysis was performed by Pierce and colleagues at Washington University. They reviewed 45 studies, of which 14 were paired studies and reported a recurrence rate of 3.1–4.3% for LIVH and 12.1% for open mesh repair [7].

In a review of recent literature, the cumulative average of operating room time for LIVH was 87 and 91.5 min for open mesh repair, which supports a number of comparative studies that report no statistical difference in OR time [8, 52, 56, 58]. However, other studies do show a statistical difference; LIVH has been shown in one meta-analysis to take 12 min longer than open mesh repair on average [53, 57]. This discrepancy is most likely secondary to the lack of standardization of open mesh repair and the learning curve for LIVH represented in earlier studies.

LIVH has been shown to have favorable results in shorter postoperative lengths of stay and overall decrease in wound infections and mesh removal [7, 10, 11, 56, 58, 59] (Table 28.2). Pierce and colleagues found wound infections to be 4.6–8-fold higher in open mesh repairs when compared with LIVH [7]. In a review of the National Surgical Quality Improvement Program (NSQIP) database, total complications were twice as high in open mesh repair in comparison to LIVH [58]. A common sequelae of LIVH are seroma formation. This complication is often underreported because it is routinely of no clinical significance. Very few studies document persistent seroma formation that required intervention.

LIVH is often accompanied with significant adhesiolysis. A dreaded consequence of extensive adhesiolysis is injury to the intestine. Injury may be a result of direct laceration secondary to sharp or blunt dissection, but heightened vigilance is required for injuries caused by traction and remote serosal injuries that may go unrecognized. In a review of the literature by LeBlanc et al., the enterotomy rate for LIVH was 1.78% out of 3925 LIVH. According to this review, approximately 18% of the time, an enterotomy is unrecognized which is associated with a mortality rate of 7.7% [28]. Some have shown a higher rate of enterotomy with laparoscopic versus open surgery in a meta-analysis [60]. Should an enterotomy occur and is recognized, the injury should be repaired, of course. The next decision is whether or not to proceed with the repair of the hernia itself. The use of a prosthesis is to be avoided in conventional teaching, but there is a growing opinion that the use of lower-weight meshes or an absorbable prothetic material might be considered in this situation as these seem to be less prone to infection. A primary repair of the hernia will be associated with a high risk of recurrence. Therefore, many experts recommend that the primary repair be avoided and the patient be returned to the operating room in several days [61].

The overall cost of LIVH has been shown to be equivalent with open mesh repair. A single institution prospectively collected data on 884 incisional hernias. There was no statistical difference in overall hospital cost for LIVH when compared to open mesh repair. LIVH was shown to have shorter length of stay, though operating time and cost of supplies were higher in LIVH. LIVH costs $6725 compared with $7445 for open mesh repair in total hospital costs and postoperative encounters [62]. Recent evidence confirmed that the minimally invasive approach is preferred due to cost, length of hospital stay, outcomes, number of days off from work, and number of outpatient postoperative visits [63].

Table 28.2 Postoperative complications

	Ballem [51]		Bencini [52]		Bencini [53]		Olmi [9]		Pringe [6]		Lomanto [8]		McGreevy [11]		Forbes [10]		Pierce [7]	
Complications	Open	Lap	Open	Lap	Open	Lap	Open	Lap	Open	Lap	Open	Lap	Open	Lap	Open	Lap	Open	Lap
Enterotomy	–	–	2%	5%	0%	4%	–	–	–	–	–	–	0%	1.5%[a]	0.9%	2.6%	1.2%	2.9%
Fecal obstruction	–	–	–	–	–	–	1.1%	1.1%	–	–	–	–	–	–	–	–	–	–
Ileus	–	–	10%	2%	–	–	–	–	–	–	10%	2%	4.2%	0%	–	–	–	–
Mesh Infxn/ removal	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.5%	0.7%	3.2%	0.9%
Neuralgia	–	–	–	–	–	–	0%	4.7%	–	–	–	–	–	–	–	–	–	–
Pulmonary embolism	–	–	–	–	–	–	1.1%	0%	0%	6.6%[b]	–	–	–	–	–	–	–	–
Seroma	9%	16%	10%	14%	3%	11%	1.1%	7%	33%	17%	6%	10%	4.2%	3%	15.5%	11.7%	12%	12.1%
Urinary retention	–	–	–	–	–	–	–	–	0%	6.6%	–	–	–	–	–	–	–	–
Wound infxn	9%	7.5%	12%	0%	8%	0%	8.2%	1.1%	16.7%	3.3%	6%	4%	8.4%	0%	10.1%	1.5%	10.4%	1.3%

[a]Unrecognized
[b]Preexisting procoagulant disorder

Obesity and LIVH

Obesity has been shown to be a major factor in hernia recurrence. In a study of 160 patients, obesity was compared to other risk factors for hernia recurrence such as smoking, diabetes, steroid use, and pulmonary disease. Obesity was the strongest predictor for hernia recurrence. Patients with a body mass index (BMI) of 38 were 4.2 times more likely to have a recurrent hernia in comparison to a patient with a BMI of 23 [20]. Congruent results were identified in a multi-institutional study of five academic centers. This retrospective review found the recurrence rate to be significantly higher in morbidly obese patients with an odds ratio of 4.3 [19].

Though some report a higher recurrence rate in obese patients, LIVH is safe and effective in this population of patients [4]. LIVH has been shown to have less risk of wound complications, greater identification of multiple occult defects, and wider mesh overlap. In a review of 168 patients at a single institution, perioperative complications after LIVH were not found to be statistically different from non-obese patients. Recurrence rates were related to defect size and size of mesh rather than obesity [64]. Ventral hernia repair is even promoted during laparoscopic bariatric surgery when concurrently identified. In patients who did not have their ventral hernia repaired during laparoscopic gastric bypass, there was an increased risk of intestinal incarceration during patient follow-up [65].

Conclusion

LIVH has a proven track record as an effective, safe, and durable option for ventral hernia repairs. There is general consensus that LIVH has comparable recurrence rates to open mesh repair, if not less risk of recurrence as seen in some prospective trials. Wound complications and mesh infections occur infrequently. Hospital stay is shortened, and increasingly, LIVH is becoming the first and only attempt at a disease that is commonly identified in 10–20% of postlaparotomy patients [4, 23, 54, 66].

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